COCKROACH (Periplanata americana) MEAL NUTRITIVE COMPOSITION

Supported by tetfund TERTIARY EDUCATION TRUST FUND

COCKROACH (*Periplanata americana*) MEAL NUTRITIVE COMPOSITION

S. O. Sule[1]*, T. A. Ojetayo[1] and A. O. Sotolu[2]
[1]Department of Forestry, Wildlife & Fisheries, Olabisi Onabanjo University, Ayetoro Campus, Ogun State, Nigeria
[2]Department of Aquaculture & Fisheries Management, Nasarawa State University, Shabu-Lafia Campus, Nigeria
*Corresponding author: sule.okanlawon@oouagoiwoye.edu.ng, okanlawon.sule@yahoo.com

Received: December 22, 2019 **Accepted:** February 20, 2020

Abstract: The nutritional potential of insect protein source as potential feed ingredient has been widely researched. Cockroach meal (*Periplanata americana*) being a readily available renewable resource animal protein food is hereby investigated for its chemical composition and fatty acid content. The proximate composition revealed crude protein content 53.10±0.09%, fat 10.56±0.11%, fibre 11.69±0.23%, ash 8.37±0.13%, moisture content 5.22±0.08%, NFE 11.10±0.32% and metabolisable energy 1482.12±9.38 KJ kg^{-1}. Mineral content analysis showed K as the highest (10007.69±79.68 mg/kg), while the other elemental nutrients were lower in concentration; P (4527.40±90.64 mg/kg), Na (4518.72±213.33 mg/kg), Ca (2174.10±15.01 mg/kg), Mg (1180.50±14.06 mg/kg), Fe (1303.37±9.77 mg/kg), Zn (185.66±2.70 mg/kg), Cu (50.22±1.52 mg/kg) and Mn (20.85±1.55 mg/kg). The essential amino acid profile revealed leucine as highest (8.29 g/100g) and tryptophan least (0.97 g/100g) with the limiting methionine (2.40 g/100g) and lysine (5.65 g/100g) while the non-essential amino acid glutamic acid was highest (13.17 g/100g) and cysteine (0.84 g/100g) was least. The saturated fatty acid ligonoceric C24:0 (21.45±0.38%) was highest and butyric C4:0 (2.72±0.26%) was least; mono-unsaturated fatty acid oleic C18:1n9 (17.35±0.24%) was highest and palmitoleic C16:1n7 (17.02±0.45%) while poly-unsaturated fatty acid linoleic C18:2n6 (16.72±0.06) was highest and arachidonic C20:4n6 (12.97±0.19) was least. This study validates the outcome of previous researches on the *Periplanata americana* and new information on its fatty acid profile. Hence, the need for further research into its digestibility and utilization as a protein source in animal feed and its health implication on livestock.

Keywords: Cockroach, entomophagy, insect meal, fatty acid

Introduction

Insect rearing could be one of the ways to enhance food and feed security (Van Huis *et al.*, 2013). The growth, reproduction, high feed conversion efficiency when reared on bio-waste with one kg of insect biomass produced from an average 2 kg of feed biomass (Collavo *et al.*, 2005). Strong recommendations have been clamoured for the use of insects as human food and animal feed and as a tool for poverty alleviation (FAO 2010; Van Huis *et al.*, 2013). The potential of insect suitability for animal feed cannot be underestimated (Van Huis *et al.*, 2013). Insects are good protein source (Ewete, 2015).

The Cockroaches (*P. americana*) represents an example of insect species such as housefly, mealworm and cricket that can be used for producing protein for use as livestock and fish feed likewise for human consumption. Oghale *et al.* (2014) reported the availability of cockroach all year round and it is presently not used in entomophagy in his study area and Odibo *et al.* (2019) reported an average of fourteen cockroaches per household and no seasonal difference in species found in human abode. The ubiquitous nature of the insect and the need for its control in food, stored products and human habitation is the opinion of Rejitha *et al.* (2014) while Ojiezah and Ogundipe (2015) raised the issue of public health concern on the insect. However, Costa-Neto and Oliveira (2000), Barbara (2013), Feng *et al.* (2014), Diehl *et al.* (2014), Latifi *et al.* (2015), Chen (2018) and Butler (2018) have allayed the fear on health and even possible use in treatment of human diseases when cultured cockroach is used as meal.

This study therefore research into the chemical composition of the *P. americana* for its consideration in livestock nutrition while focusing on Rumpoldt and Schluter (2013) with regards to fatty acid content.

Materials and Methods

Cockroaches *P. americana* were collected by Year Two students of College of Agricultural Sciences, Olabisi Onabanjo University and preparation of samples was done according to Ayssiwede *et al.* (2011) and Sule and Ojetayo (2016). Sterilization was carried out in an autoclave (YX-280A) for 10 min at 150 psi and oven dried at 50°C for 8 h before pulverizing with electric blender. Proximate analysis was according to AOAC (2005) and metabolizable energy calculated according to Finke (2002). Mineral analysis was determined by wet ashing with perchloric acid and nitric acid and macro and micro element separated using atomic absorption spectroscopy (AAS) at the Department of Agronomy, fatty acid profile was determined spectrophotometrically at the Department of Animal Science, University of Ibadan, according to the methods of Baker (1964); Lowry and Tinsley (1976). Amino acid analysis was by the use of Model 120A PTH Amino acid Analyzer at the University of Jos. Samples n=24 adult *P. americana* lengths, wet and dry weight were carried out using metre rule and sensitive scale. Descriptive statistics using IBM SPSS 20 was used for data analysis and results reported as means ± SE.

Results and Discussion

The size of adult *P. americana* in this study (Table 1) was within the range reported for adult *Eublaberus distant, Gromphadorhnia portentosa* by Oonincx and Dierenfeld (2012).

The proximate analysis (Table 2) was similar to Bernard and Allen (1997) for the same species and that of *Blaptica dubia* (Lam Pei Yee *et al.*, 2016) lower to that of Ayssiweide *et al.* (2011), Rumpoldt and Schluter (2013), Amariei *et al.* (2014), Sule and Ojetayo (2016) but falls within the range reported by Rumpoldt and Schluter (2013) for *P. americana* and Oonincx and Dierenfeld (2012) for other Blattodea species. Crude protein (53.10%) was similar to that of cricket meal and raw fishmeal in Taufek *et al.* (2016); Egan *et al.* (2014) for caterpillar larva but greater than for all edible insects reported by Banjo *et al.* (2006). The use of cockroach meal, its acceptance by consumers and legality of inclusion in livestock nutrition will generate debate as this is also the view of Rumpoldt and Schluter (2015). Crude fibre (11.69%) was

higher in this study than values reported by Ayssiweide *et al.* (2011), Rumpoldt and Schluter (2013) and within the range of Oonincx and Dierenfeld (2012).Ash (8.37%) followed the same trend and higher than values reported by Ayssiweide *et al.* (2011) and Amariei *et al.* (2014) but falls within the range reported by Oonincx and Dierenfeld (2012). Lipid content (10.56%) was lower to the values of Ayssiweide *et al.* (2011), Oonincx and Dierenfeld (2012), Rumpoldt and Schluter (2013), Amariei *et al.* (2014) while Lam Pei Yee *et al.*, (2016) values were three times higher than for this study when used in domesticated cat dietary inclusion. The metabolizable energy (1482.12 kcal) is similar to Finke (2012) for Turkestan cockroaches' nymphs. The finding of this study does not agree with the report of Abulude *et al.* (2007) for the same species especially with regards to crude protein. Diehl *et al.* (2014) reported that cockroach is a promising insect to be used as animal feed.

Table 1: Length and weight in relation to production of one kilogramme meal from samples

(n=24)	Wet weight (g)	Dry weight (g)	Length (cm)
Total	25.29	8.99	82.60
Mean average	1.05±0.06	0.28±0.02	3.44±0.06
Range	0.63 – 1.79	0.21 – 0.61	2.80–4.00
Number to make 1 kg	960	2650	---------

Table 2: Proximate analysis of cockroach meal

Proximate	%
Crude Protein	53.10±0.09
Crude fat	10.56±0.11
Crude fibre	11.69±0.23
Ash	8.37±0.13
Nitrogen free extract	11.10±0.32
Moisture content	5.22±0.08
Metabolisable energy (Kcal)	1482.12±9.38

Table 3: Mineral content profile of cockroach meal

Mineral	(mg/kg)
Phosphorus (P)	4527.40±90.64
Calcium (Ca)	2174.10±15.01
Magnesium (Mg)	1180.50±14.06
Potassium (K)	10007.69±79.68
Sodium (Na)	4518.72±213.33
Manganese (Mn)	20.85±1.55
Iron (Fe)	1303.37±9.77
Copper (Cu)	50.22±1.52
Zinc (Zn)	185.66±2.70

The mineral content (Table 3) for Na (4518.72 mg/kg), K (10007.69 mg/kg) and Ca (2174.10 mg/kg) were higher than values reported by Ayssiweide *et al.* (2011), similar to Bernard and Allen (1997) and within the range of macro mineral, Mn (20.85 mg/kg) and Zn (185.66 mg/kg) (Oonincx and Dierenfeld, 2012) while Fe (1303.37 mg/kg) and Cu (50.22 mg/kg) in this study were higher.

The analysis of fatty acid (Table 4) revealed that the EPA and DHA were absent in *P. americana* and this corroborates the findings of Finke (2002), Kulma *et al.* (2016), Barroso *et al.* (2014) and Tzompa-Sosa *et al.* (2014). In the SFA lignoceric (21.45%) was highest followed by oleic (17.35%) in MUFA and linoleic (16.72%) in PUFA these were in line with the findings of Kulma *et al.* (2016) and Tzompa-Sosa*et al.* (2014) for the blattodea specie and Mohammed (2015) for migratory locust. The fatty acids in this study were higher than the values reported for moth caterpillar by Paiko *et al.* (2014). The butyric (2.72%) and valeric (6.63%) SFA has been indicted in fermentation and metabolism in rumen of lactating cow (Muller, 1987).

Table 4: Fatty acid composition of cockroach meal

Saturated Fatty Acid (SFA)	%
Acetic C2:0	12.99±0.43
Propionic C3:0	7.05±0.05
Butyric C4:0	2.72±0.26
Valeric C5:0	6.63±0.29
Caprylic C8:0	5.91±0.13
Lauric C12:0	11.36±0.38
Myristic C14:0	10.84±0.08
Palmitic C16:0	21.16±0.13
Margaric C17:0	14.07±0.09
Stearic C18:0	16.98±0.05
Behenic C22:0	21.12±0.41
Ligonoceric C24:0	21.45±0.38
Mono-Unsaturated Fatty Acid (MUFA)	
Palmitoleic C16:1n7	17.02±0.45
Oleic C18:1n9	17.35±0.24
Poly-Unsaturated Fatty Acid (PUFA)	
Linoleic C18:2n6	16.72±0.06
Arachidonic C20:4n6	12.97±0.19

Table 5: Amino acid profile of cockroach meal

Amino acid	g/100g
Arginine	6.2
Histidine	4.21
Isoleucine	3.66
Leucine	8.29
Lysine	5.65
Methionine	2.40
Phenylalanine	5.14
Threonine	3.19
Trypthophan	0.97
Valine	4.00
Alanine	3.94
Aspartic acid	9.92
Cysteine	0.84
Glutamic acid	13.17
Glycine	3.61
Proline	4.06
Serine	3.70
Tyrosine	3.09

Amino acid has been known to indicate the protein value of feed ingredient. In Table 5, methionine (2.40 g/100g), threonine (3.19 g/100g) and valine (4.00 g/100g) were lower than values obtained by Rumpoldt and Schluter (2013) while all the essential amino acid were higher in value when compared to Rumpoldt and Schluter (2013). When compared to AFRIS/Feedipedia (2012) for fishmeal eight of the EAA compared favourably with that of this study while lysine and threonine were higher in value stressing the fact of fishmeal superiority over all other ingredients. Aspartic acid (9.92 g/100g) was not detected by Rumpoldt and Schluter (2013) but was a major focus in this study. Methionine (2.40 g/100g) was higher than values of blattodea species (Kulma *et al.*, 2016) while variations exist in lysine (5.65 g/100g) of this study with that of Kulma *et al.* (2016).

Conclusion

This study showed that constituent of *P. americana* are within the range reported in literature. The nutritive value should be used in the nutrition of livestock for optimal production while considering the health implication on consumption of end product.

Conflict of Interest

Authors declare there is no conflict of interest this study.

References

Abulude FO, Folorunso OR, Akinjagunla YS, Ashafa SL & Babalola JO 2007. Proximate composition, mineral levels and phytate contents of some alternative protein sources (cockroach, *Periplanata americana*, soldier ant *Oecophylla species* and earthworm *Lubricus terrestics*) for use in animal feed formulation. *Asian J. Ani. and Veterinary Adv.*, 2(1): 42-45.

Amariei Oana-Gabrie A, Bende Csilla & Boncut Paula-Eleria 2014. Determination of crude chemical composition of madagascar hissing cockroach (*Gromphadorhina potentosa*) and possible uses in animal feeding as source of protein. www.usamvcluro/simpo_stud/files/2014/medicina_veterinara/preclinice/Amarieioana-Gabrielaeng.pdf.

AOAC (Association of Official Analytical Chemistry) 2005. Official Method of Analysis of AOAC.

Ayssiwede SB, Zanmenou JC, Isa Y, Hane MB, Dieng A, Chrysostome CAAM, Houinato MR, Hornick JL & Missohou A 2014. Nutrient composition of some unconventional and local feed resources available in Senegal and recoverable in indigenous chickens or animal feeding. *Pak. J. Nutr.*, 10(8):707-717.

Baker D 1964. *Journal of the American Oil Chemists Society*, 41: 21.

Banjo AD, Lawal OA & Songonuga EA 2006. The nutritional value of fourteen species of edible insects in Southwestern Nigeria. *Afri. J. Biotechn.*, 5(3): 298-301.

Barbara Demick 2013. Cockroach Farms Multiply in China. *Los Angeles Times* October 15. https://www.latimes.com/world/la-fg-c1-china-cockroach-20131015-dto-htmlstory.html

Barroso FG, de Haro C, Sánchez-Muros MJ, Venegas E, Martínez-Sánchez A, Pérez-Bañónc C 2014. The potential of various insect species for use as food for fish. *Aquaculture,* 422–423: 193–201.

Bernard JB & Allen ME 1997. Feeding captive insectivorous animals: Nutritional aspect of insects as food. Nutrition Advisory Group Handbook, Fact Sheet 003. Silver Spring: American Zoo and Aquarium Association, pp. 1-7.

Collavo A, Glew RH, Huang YS, Chuang LT, Bosse R & Paoletti MG 2005. House cricket small-scale farming. In: MG Paoletti, ed., Ecological Implications of Minilivestock: Potential of Insects, Rodents, Frogs and Snails. *New Hampshire, Science Publishers*, pp. 519–544.

Costa-Neto EM & Oliveira MVM 2000. Cockroach is good for Asthma: Zootherapeutic Practices in Northeastern Brazil. *Human Ecology Review, Vol. 7, No. 2,*

Diehl E, Valsmakis G, van der Veen I, Di Magliano LP, Sauren S & Jager W 2014. Alternative Invertebrate Protein as a Source for Animal Feed: Implications and Constraints Towards Sustainable Protein Recycling, p. 120.

Egan BA, Tom SR, Minter LR, Addo-Bediako A, Masoko P, Mphori M & Olivier PAS 2014. Nutritional significance of the edible insect, *Hemijana variegate* Rothschild (Lepidoptera:Eupterotidae), of the Blouberg Region, Limpopo, South Africa. *African Entomology,* 22(1): 15-23.

Ewete FK 2015. Insects: Friends or Foe? Inaugural Lecture, University of Ibadan, p. 53.

Finke MD 2002. Complete nutrient composition of commercially raised invertebrates used as food for insectivores. *Zoo Biol.,* 21: 269–285,.

Finke MD 2012. Complete Nutrient Content of Four Species of Feeder Insects. *Zoo Biology*, 31(1): 1–15.

Gavin Butler 2018. China is Breeding an Army of Cockroaches to Eat its Food Scraps *South China Morning Post* 11 December. https://www.vice.com/en_au/article/bjep7z/china-is-breeding-an-army-of-cockroaches-to-eat-its-food-scraps

Kulma M, Plachý V, Kouřimská L, Vrabec V, Bubová T, Adámková A & Hučko B 2016. Nutritional value of three *Blattodea* species used as feed for animals. *J. Animal and Feed Sci.*, 25: 354–360.

Lam Pei Yee, Kumara Thevan, Nurul Syaza Abdul Latifi & Visweswara Rao P 2016. Dubia Roach (*Blaptica dubia*) as an alternative protein source for animal feed. *J. Biochem. Biopharmac. and Biomed. Sci.,* 1(1): 31-39.

Latifi M, Mohammad Yousef Alikhani, Aref Salehzadeh, Mansour Nazari, Ali Reza Bandani & Amir Hossein Zahirnia 2015. The antibacterial effect of american cockroach hemolymph on the nosocomial pathogenic bacteria. *Avicenna J. Clin. Microb. Infec*., 2(1): e23017.

Lowry RR & Tinsley LJ 1976. *J. Am. oil: Chemists Soc.,* 53: 470.

Mohamed EHA 2015. Fatty acids contents of the edible migratory locust *Locusta migratoria*, Linnaeus, 1758 (Orthoptera:Acrididae). *Int. J. Adv. in Pharmacy, Biol. and Chem*., 4(4): 746-750.

Muller LD 1987. Branched Chain Fatty Acids (Isoacids) and Valeric Acid for Ruminants. Paper No. 7619 Journal Series of the Pennsylvania Agricultural Experiment Station, pp. 9-12.

Odibo EO, Egwunyenga AO & Ojionwuna CC 2019. Seasonal distribution of cockroaches' species in Abraka, Delta State, Nigeria. *FUW Trends in Sci. and Techn. J.,* 4(1): 163-168.

Oghale Okorie, Diane Avaoja & Ifediora Nwana 2014. Edible insects of the Niger Delta Area in Nigeria. *J. Nat. Sci. Res.,* 4(5).

Ojiezah TI & Ogundipe OO 2015. Microbiology of cockroaches- a public health concern. *Int. J. Scientific Res.,* 4(4): 485-488.

Oonincx DGAB & Dierenfeld ES 2012. An investigation into the chemical composition of alternative invertebrate prey. *Zoo Biology*, 31(1): 40-54.

Paiko YB, Jacob JO, Salihu SO, Dauda BEN, Suleiman MAT & Akanya HO 2014. Fatty acid and amino acid profile of emperor moth caterpillar (*Cirina forda*) in Paikoro local government area of Niger State, Nigeria. *Am. J. Biochem.,* 4(2): 29-34.

Rejitha TP, Reshma JK & Anu M 2014. Study of repellant activity of different plant powders against cockroach (*Periplanat americana*). *Int. J. Pure and Appl. Biosci.,* 2(6): 185-194.

Riddick EW 2013. Insect protein as a partial replacement for fishmeal in the diets of juvenile fish and crustaceans: Invertebrates and entomopathogens. In: JA Morales-Ramos.

Rumpold BA & Schluter OK 2013. Nutritional composition and safety aspects of edible insects. *Molec. Nutr. & Food Res*., 57: 802-823.

Rumpold BA & Schluter OK 2015. Insect-based protein sources and their potential for human consumption: Nutritional composition and processing. *Animal Frontiers,* 5(2): 20-24.

Sanchez-Muros MJ, Barroso FG & Manzano-Agugliaro F 2014. Insect meal as renewable source of food for animal feeding: A review. *J. Clean. Prod*., 65: 16–27.

Stephen Chen 2018. A farm in China is using AI to breed more cockroaches in a year than there are people on earth. *South China Morning Post*https://www.businessinsider.com/a-chinese-farm-produces-6-billion-cockroaches-a-year-for-medicinal-use-2018-4?IR=Te

Sule SO & Ojetayo TA 2016. Proximate and Mineral Composition of Cockroach Meal. *47th Annual Conference of Entomological Society of Nigeria*, 10th-13th October, University of Ilorin, Kwara State, Nigeria (Poster presentation).

Taufek NM, Muin H, Raji AA & Razak SA 2016. Apparent digestibility coefficient and amino acid availability of cricket meal *Gryllus bimaculatus* and fishmeal in African catfish *Clarias gariepinus* diet. *J. World Aquac. Soc.,* 47(6): 798-805.

Tzompa-Sosa DA, Liya Yi, Hein JF, van Valenberg, Martinus AJS, van Boekel, Catriona MM Lakemond 2014. Insect lipid profile: aqueous versus organic solvent-based extraction methods. *Food Research International*, 62: 1087–1094.

van Huis A, Van Itterbeeck J, Klunder H, Mertens E, Halloran A, Muir G & Vantomme P 2013. Edible Insects - Future Prospects for Food and Feed Security. FAO Forestry Paper17.